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PORTABLE AIR COMPRESSOR/TANK DEVICE

This application claims the benefits of provisional application Serial No. 60/426,294 filed November 14, 2002.

FILED OF THE INVENTION

The invention relates to a portable, low cost air supply device for accumulating and dispensing compressed air and powered by photovoltaic energy.

BACKGROUND OF THE INVENTION

US Patent 6 367 259 describes an air compressor system that includes a rotary induction motor, motor control circuitry, expensive large capacitors, and associated packaging. To date, air compressor systems that accumulate energy from photovoltaics have been made up of conglomerations of large static devices, working together and coordinated by complicated control circuitry and sensors. These systems are commonly formatted as banks of batteries or banks of large expensive capacitors. Such storage devices drive induction motors, which then finally drive compressors.

SUMMARY OF THE INVENTION

An embodiment of the invention provides an air supply device and method that accumulate and distribute compressed air without the use of the large static devices referenced above, that can be hand carried to the point of use with a size scale easily applied by the end user, and that eliminates the need for a rotary induction motor, motor control circuitry, expensive large capacitors, and associated packaging.

One illustrative embodiment of the invention involves a self-replenishing, portable air supply device that includes an air reservoir tank and one or more photovoltaic cells disposed exterior of the air reservoir tank. The photovoltaic cell(s) provide(s) electrical power to a capacitor, which intermittently discharges to a solenoid, which then mechanically compresses air into the reservoir tank. In a preferred embodiment of the invention, the capacitor and solenoid and other related components are located inside the air reservoir tank.

The invention optionally provides on the air reservoir tank one or more of a flashlight, a self-retracting hose reel, a hose pressure indicating gauge/LCD readout, a manually activated valve to dispense compressed air, and a connector to secure the portable reservoir tank in a location of use (i.e. pick-up truck bed). The invention also envisions optionally providing one or more remote-

mounted photovoltaic cell(s) to allow the air supply device to serve as an imbedded power unit within a larger system.

The invention is advantageous to improve the manufacturability and affordability of a portable air compressor system by virtue of reduced number of component parts, simplified integral packaging (placing sensitive components inside the air reservoir tank), and enabling the use of a very small, and exponentially cheaper capacitor. Other advantages of the invention will become more readily apparent from the following description taken with the following drawings.

DESCRIPTION OF THE DRAWINGS

Figure 1 is a schematic view of an air supply device pursuant to an embodiment of the invention shown for use in inflating a pick-up truck tire.

Figure 2 is a perspective view of an air supply device to an embodiment of the invention with the air reservoir tank partially broken away to show the portion of the solenoid pump assembly residing inside the tank.

Figure 2A is an enlarged view of the solenoid pump assembly.

Figure 3 is a sectional view of the solenoid pump assembly and air reservoir tank wall, depicting the pneumatic circuit. The circuit board B and capacitor and trigger device thereon are shown schematically for convenience.

Figure 4 is a schematic view showing the photovoltaic cells and related electronic components relative to the air reservoir tank, depicting the electrical circuit.

Figure 4A is an enlarged view of the electrical trigger device of Fig. 4.

Figure 5 is a perspective view of the air supply device showing the air reservoir tank having thereon a flashlight, a self-retracting hose reel, a hose pressure indicating gauge/LCD readout, a manually activated valve to dispense compressed air, and a locking lug to secure the portable reservoir tank in locations of use (i.e. pick-up truck bed).

Figure 6 is a perspective view showing the air supply device having a lug for mounting the air supply device on the bed of pick-up truck.

Figure 7 is an elevational view of the air supply device having a manual trigger thereon actuated to dispense compressed air from the air reservoir tank.

Figure 7A is an enlarged view of the manual trigger.

DESCRIPTION OF THE INVENTION

Referring to Fig. 1, an air supply device and method pursuant to an illustrative embodiment of the invention comprises an air reservoir tank 1 of conventional fabrication (mild steel, or aluminum, or plastic composite construction) with an integral carry handle 21 and attached supporting feet 20 for resting on a horizontal surface. A pipe nipple 2, Fig. 2 is disposed on and extends through and into the air reservoir tank 1. A solenoid pump assembly 19 is configured as a plug received in the pipe nipple 2, with certain mechanical and electrical circuitry of the solenoid pump assembly disposed in, and totally enclosed within, the air reservoir tank 1 as will become apparent below.

On the exterior surface of tank 1 is/are mounted one or more photovoltaic cell(s) 14. The energy from the photovoltaic cell(s) 14 is used to charge intermittently solenoid 8 of the solenoid pump assembly 19 using an electrical circuit shown in Fig. 4. Solenoid 8 and its enclosed plunger 7 reside in the tank 1, Fig. 3, and are configured to function as an air compressor pump when combined with valve manifold 11. The solenoid 8 includes a housing with a threaded or flanged end that is threaded or bolted onto the valve manifold 11 to join them together as shown in Fig. 3. The combination of the solenoid 8 and valve manifold 11 is referred to as the solenoid pump assembly 19. On it's retract stroke, plunger 7, functioning as a piston, draws atmospheric air through the externally protruding tank valve 3 of the solenoid pump assembly 19. Once the solenoid 8 is energized, plunger 7 advances, compressing air past spring-biased check valve 13 and into the air reservoir tank 1. The solenoid 8 can be a commercially available solenoid, such as Ledex brand size 3EC model available from Saia-Burgess, Inc.

The valve manifold 11 has attached, or built integral to it, devices including 1) a pressure relief valve 6, to prevent tank 1 over pressurization; and 2) a Schrader style tank valve 3, functioning as an air intake, back flow check valve, and allowing the filling of tank 1 from an external compressed air source. Further devices attached or built integral to manifold block 11 include gauge port 5 for mounting a pressure indicator 27 for gauging discharge pressure; discharge hose connector 12; and optional discharge valve 10 for manually controlled dispensing of compressed air. Discharge hose 4 is a flexible tube connected to discharge hose connector 12. Discharge hose 4 is used for dispensing compressed air from within tank 1, and can be configured as a static shape, coiled, or combined with an optional self-retracting hose reel 23 as shown in Fig. 5.

An electrical trigger device 16, Fig. 4, is provided and determines when there is enough electrical charge (energy) stored in capacitor 15 as an electrical power storage device to energize

solenoid 8. Capacitor 15 will be of low cost and small size, generally in the 2200 micro Farad size range. The trigger device 16 in its essential embodiment includes a diode 16a and transistor 16b arranged as shown in Fig. 4A that function together to detect a fully charged capacitor 15, distribute this stored energy to solenoid 8, and then reset the circuit so that the energy supplied by photovoltaic cell(s) 14 can recharge capacitor 15 to repeat the cycle. The capacitor 15 trigger device 16 and other electrical components are mounted on a circuit board B located inside the tank 1, Fig. 2. The circuit board is fastened by a U-shaped bracket to the solenoid housing as shown in Fig. 3. If it is desired to give an indication external of the tank 1 that the solenoid 8 is energized, LED 17 can be optionally installed in the circuit as shown in Fig. 4. A current limiting device 18, which may comprise a resistor, may be required in the circuit dependent on the current handling characteristics of photovoltaic cell(s) 14.

The air supply device also may contain the following optional features: (a) a pressure switch 28 to shunt excess electrical potential from photovoltaic cell(s) 14 to the charging of a rechargeable flashlight 22, Fig. 5, that is disposed on, and preferably built integral to the carry handle 21 such that the flashlight body functions as the carry handle for tank 1; (b) an AC/DC or DC/DC power adapter 29 for powering the air supply device from an external electrical source; (c) a C-shaped (or other shaped) strap connector 24, Fig. 6, which is fastened on the air reservoir tank 1 and which receives and is lockable onto an elongated male bracket 25 attached to a truck bed, Fig. 6 (or other structure) when the air supply device is positioned on the truck bed proximate the front wall thereof so as to prevent the theft of the device, the bracket 25 having a punched or otherwise-formed hole to receive a common padlock in a manner that also passes through the strap connector 24 to lock the connector and the bracket together; (d) air dispensing valve 10 movable relative to valve seat 10a and configured as a manually depressed button, or activated by a lever 30 disposed on a carrying handle 21 attached to tank 1, Fig. 7, such that when the lever 30 is manually squeezed, the lever rocks on pivot pin 31 in a manner to depress air dispensing valve 10, which than opens relative to seat 10a and supplies compressed air to the discharge hose 4; and (e) a pressure gauge 26, Fig.. 5, for indicating tank air pressure. In an alternative embodiment of the invention, the discharge hose connector 12 can be omitted and replaced with hard piping so that the air supply device can be used as an integral power supply subcomponent to a larger system. The air reservoir tank 1 may or may not require customizing to conform within the encompassing larger system and may or may not require the remote location of the photovoltaic cells 14 as a power source. Still further, the solenoid pump

assembly 19 alternatively may be mounted or disposed externally to an air reservoir tank 1 as either a retrofit to an existing passive air tank, or as an alternative way to construct an air supply device pursuant to another embodiment of the invention.

In operation, photovoltaic cell(s) 14 produce electric current through exposure to any incident light energy. The electric charge is stored in capacitor 15. Once capacitor 15 achieves a charge sufficient enough to overcome the breakdown voltage of the trigger device 16, the electrical charge is then free to pass through to the coil of solenoid 8, Fig. 4, to power the solenoid. An energized solenoid 8 creates an electromagnetic flux passing through the center of the solenoid 8. Plunger 7, which is located in the center of solenoid 8, resists the electromagnetic flux, which causes plunger 7 to thrust rapidly upwards out of solenoid 8. The air on the leading surface of plunger 7 is compressed through check valve 13 and into the air reservoir tank 1. The charge in the capacitor is diminished rapidly and plunger 7 self centers back into solenoid 8 as the flux relaxes. Gravity helps the plunger 7 retract into the solenoid coil in vertical plunger orientations as shown in Fig. 3. In other plunger orientations or to speed up retraction of the plunger 7, a retract spring 32 optionally may be provided as shown in Fig. 3 to bias the plunger to this end. Additional plunger retraction speed can be achieved by modifying the trigger device 16 to not just relax the current flow in solenoid 8, but to reverse the current flow to thereby forcibly retract the plunger 7 within the solenoid 8. The withdrawal of plunger 7 creates a slight low-pressure area within the cavity of valve manifold 11. This vacuum is relieved by atmospheric air pressure overcoming the valve stem seating pressure in Schrader style tank valve 3 and enters the valve manifold 11 internal cavity. The air supply device is now ready for another cycle. The frequency of cycles will depend on available light, but will most likely not exceed 2 cycles per second at maximum sunlight due to the duty cycle limitations of most commonly commercially available solenoids.

Once the air reservoir tank 1 is at the maximum designed pressure, the backpressure from the compressed air will counterbalance the thrust force of plunger 7, and the plunger 7 will no longer be able to further compress air into the tank. Plunger 7 will be stalled, with capacitor 15 continuing to dissipate energy into solenoid 8. This "self maintaining" mode can be held indefinitely until gradual leakage reduces air volume to the point where the plunger 7 can move forward and replace the escaped air. Alternatively, a pressure switch 28 can detect a full tank of air, and disconnect the solenoid driving circuit shown in Fig. 4. The pressure switch 28 can then optionally redirect the electric potential to charging a flashlight 22, which would be beneficial for nighttime use of the

invention. The flashlight 22 may be built into the carry handle 21 of tank 1 so as to prevent loss/theft of the light. The flashlight 22 will shine across and illuminate the pressure indicator 27 at gauge port 5 as well as illuminate whatever equipment is receiving the compressed air being dispensed from the air supply device.

Although certain illustrative embodiments of the invention have been described herein, those skilled in the art will appreciate that the invention is not limited thereto and that changes, modifications and the like can be made thereto without departing from the spirit and scope of the invention as set forth in the appended claims.